At-source hospital wastewater treatment to eliminate harmful pharmaceuticals: A novel approach using UV-LED activated photocatalytic nanomaterials

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Hydro Nation Scholars Programme 10th Anniversary - 2022

Introduction

- Trace or ultra-trace concentrations of specific drugs in hospital wastewater can have toxic effects.
- Effective wastewater treatment is urgently needed to eliminate persistent drugs, prevent accumulation in food chains and future risks to human health.
- Photocatalysis is a promising approach to remove drugs and their metabolites via light-promoted synthesis of reactive oxygen species (ROS), which can oxidise and eliminate organic drug compounds.

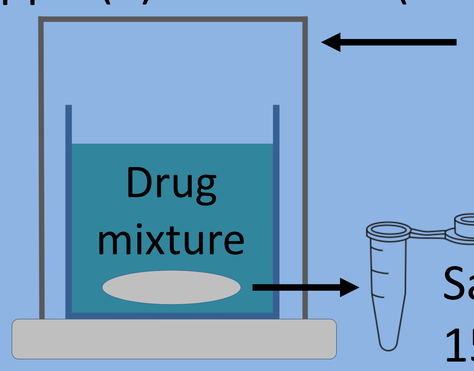
Methods

Test drug: Paracetamol

Inexpensive, UV-light effective (wide band gap) nanomaterials:

Zinc Oxide ZnO (3.37 eV), Titanium Dioxide TiO_2 (3.21 eV)

Narrow band gap nanomaterial for comparison:
Copper(II) oxide CuO (1.24 eV)



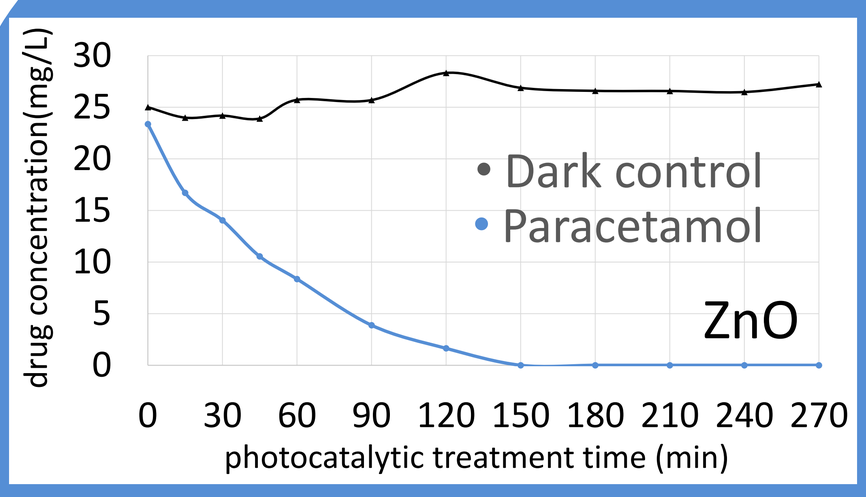
Box coated with aluminium foil and adhesive 60 W UV LEDs (365-370nm)

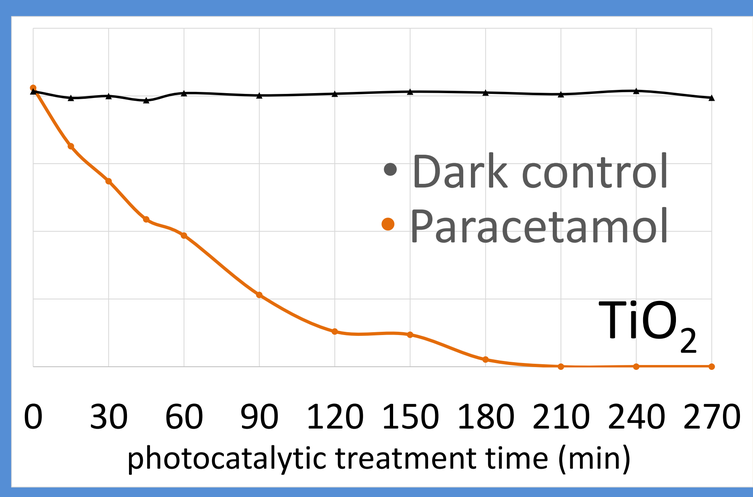
Sampling intervals:
15 – 30 min

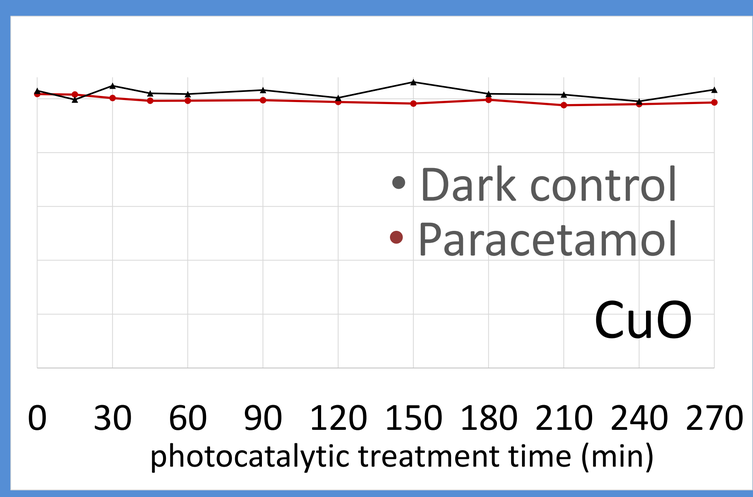
Future

Immobilise photocatalytic nanomaterials on carbon-based supports via high-temperature calcination in a furnace

~90 % paracetamol decay after 2h photocatalysis



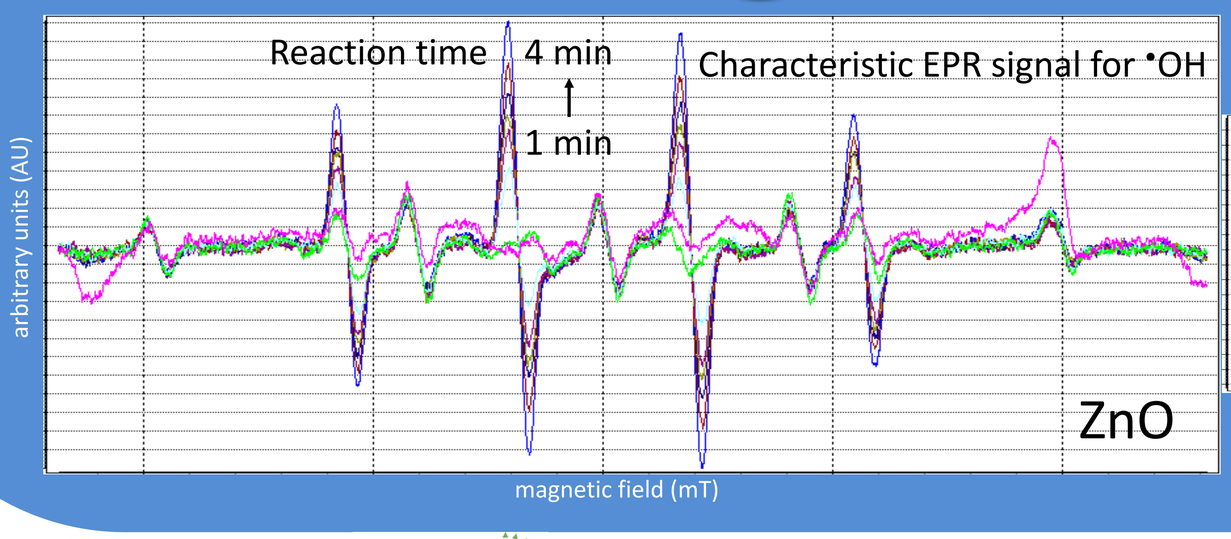




Electron Paramagnetic Resonance spectroscopy (EPR) was used to identify ROS-species with unpaired electrons such as hydroxyl radicals ($^{\bullet}OH$) which may promote photocatalytic drug removal.

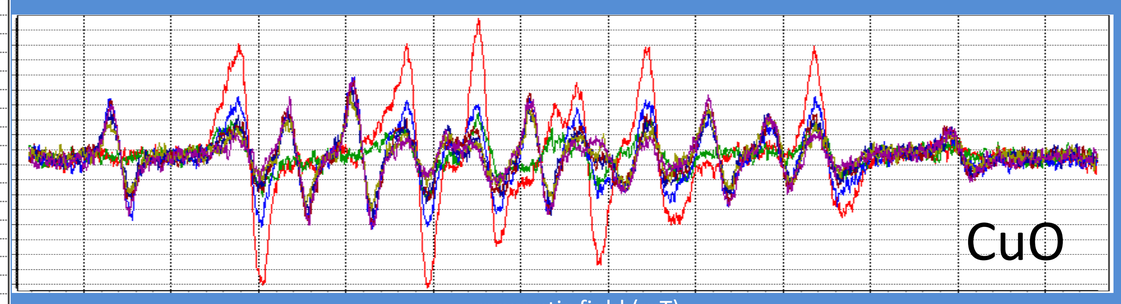
ZnO activated by UV-light produces $^{\bullet}OH$ and a 1st order drug concentration decrease can be demonstrated.

$^{\bullet}OH$ → 



CuO exposed to UV-light does not produce $^{\bullet}OH$ and no effect on the initial drug concentration can be seen.

No characteristic EPR signal for $^{\bullet}OH$



Supervisory Team
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